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A retrospective look at the development and expansion of the Southwestern Gulf of St. Lawrence snow crab, Chionoecetes opilio, fishery.

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Abstract

The evolution of the Southwestern Gulf of St. Lawrence snow crab, Chionoecetes opilio, fishery was studied through a survey among New Brunswick commercial fishermen in 1989. Since the start of the fishery, a constant increase in the size, power and hold capacity of the boats is noted. The results of the survey showed an important evolution of the navigation and communication equipment used on snow crab boats in the early 1980's. The use of Loran C, radars, VHF radios and lights contributed to increasing the fishing power of the fleet. The fishermen could therefore fish at night, stay at sea for longer periods and work at greater distances from home port. The survey also revealed an important evolution of the fishing effort in this fishery. The changes in the shapes and sizes of traps and its effect on the fishery is examined. An increase in the landings from 1978 (10462 t) to 1982 (31585 t) can be attributed to the expansion of the fishery and the more efficient harvesting of the resource rather than an increase in the stock biomass.

Résumé

L'évolution de la pêcherie de crabe des neiges, Chionoecetes opilio, dans le Sud-ouest du Golfe du Saint-Laurent a été étudié par le biais d'un questionnaire distribués aux pêcheurs commerciaux du Nouveau-Brunswick en 1989. Depuis le début de la pêcherie, une augmentation constante de la taille, de la puissance et de la capacité de la cale des bateaux a été noté. Les résultats du sondage ont démontré une évolution importante des équipements de navigation et de communication utilisés sur les bateaux de pêche au crabe au début des années 80. L'utilisation des Loran C, des radars, des radio VHF et des lumières a contribué à augmenter la puissance de pêche de la flotille. Les pêcheurs pouvaient alors pêcher pendant la nuit, rester en mer pour de plus longues périodes et travailler à des distances plus éloignées des ports d'attache. Le sondage a aussi révélé une importante évolution dans l'effort de pêche dans cette pêcherie. Les changements dans la forme et la taille des casiers et leurs effets sur la pêcherie est examiné. L'augmentation des débarquements de 1978 (10462 t) à 1982 (31585 t) peut être attribuée à cette expansion et à une récolte plus efficace de la ressource plutôt qu'à une augmentation de la biomasse du stock.

INTRODUCTION

Snow crab, Chionoecetes opilio, is the most important commercially exploited crab species in eastern Canada (Figure 1). The Southwestern Gulf snow crab fishery (zone 12) is not old, some fishing activity started around 1966 in coastal areas (Eastern Baie des Chaleurs and Baie de Gaspé) and it expanded progressively its activities towards Magdalen Island concentrating on Orphan and Bradelle banks. The creation of restricted inshore zones (Cape Breton zones 18 and 19) in 1978 and exploratory coastal fishing zone (P.E.I. zones 25 and 26) in 1985 redefined the "Southern Gulf snow crab fishery" (Figure 2).

The history of this fishery can be divided into four periods: I) an exploratory period, II) a period of industry development, III) a growth period and IV) a period of decreasing catches (Figure 3). The fishery began in 1966, with rapidly expanding annual catches reaching 7580 t in 1969, and then fluctuating within the range of 4632 t to 7568 t until 1978 when it attained 10462 t. Landings increased afterwards to around 15000 t in 1979 and 1980 and reached a peak of 31500 t in 1982. Subsequently, the landings decreased slightly, levelling off between 24000-26000 t from 1983 to 1986. In 1987, the landings drastically dropped to 11782 t, the lowest level since 1978 and remained comparable to the previous season in 1988 (12355 t). In 1989, after landing 7880 t of crab, the fishery prematurely closed due to the high incidence of newly molted crabs in the commercial catch. In 1990, a management regime was enforced with an annual quota level of 7000 t in order to protect the remaining stock as well as to attempt to rebuild the snow crab stocks in the Southwestern Gulf of St. Lawrence.

Trends in the landings in the Southwestern Gulf of St. Lawrence fishery between 1966 and 1981 are not considered to be directly related to the abundance of the resource, but rather reflect the changes in the fishing technology and the expansion of the fishing grounds in relation to the availability of the resource. The changes of fishing effort is noteworthy. For example, the shapes and sizes of the traps have changed continuously since the beginning of the zone 12 snow crab fishery: small rectangular traps (1.5 m x 1.5 m) were replaced by larger ones (1.8 m x 1.8 m) followed by their replacement with the pyramidal and conical traps. Furthermore, the introduction of lights on the vessels in early 1980's allowed night work and increased the number of trap hauls per day. It was thus noted in 1983 that the unit of effort used over the years had been inconsistent (Bailey and Cormier, 1983). Cormier (1984) also noted that even though the effort by way of the number of traps had not increased significantly, the effort level

probably increased due to competition among fishermen to get a larger share of the resource.

After having reached its peak in landings with an evenly distributed fishing effort over the whole fishable grounds (Mallet et al., 1989) using a high level of fishing technology (1981-1986), a drastic decrease in the landings are observed in 1987. The relationship between annual averaged CPUE's versus annual total estimated fishing effort suggests some drastic changes in this fishery (Figure 4). The high catch rates of the 1981-86 period were not observed from 1987-89 even though the effort levels were similar.

Little information is available on the evolution of the snow crab fishery in terms of changes in technology. In an attempt to better relate the effects of technology and fishing pattern on the evolution of the snow crab fishery landings, a survey was conducted among the New Brunswick fleet. This paper analyses the results gathered from the questionnaire.

MATERIAL AND METHODS

A survey of the snow crab fishery was conducted by the Department of Fisheries and Oceans, Science Branch (Invertebrates Division) in collaboration with the Centre Universitaire de Shippagan. The survey was directed at the New Brunswick fleet which represents the largest group of fishermen in the Southwestern Gulf of St. Lawrence snow crab fishery. It took place in the spring and summer of 1989 and involved a total of 49 fishermen. A summer student visited each fisherman in order to assist them with the questionnaire which was composed of the following questions:

1 - What year did you start fishing snow crab ?;
2 - Was the fishing permit mandatory ?;
3 - What kind of vessels were you using ?;
4 - What was the size of the vessels ?;
5 - What was the engine power of these vessels ?;
6 - What was the maximum hold capacity of the dock ?;
7 - How many crew members were on the vessels ?;
8 - What year did you introduce lights on the vessels ?;
9 - What year did you introduce radars ?;
10 - What year did you introduce sounders ?;
11 - What year did you introduce electronic positioning systems ?;
12 - What year did you introduce communication systems ?;
13 - What type and size of traps were you using ?;

14- Were the traps moved around often on the fishing grounds ?;
15- How far from shore were you fishing ?;
16- How many days were you staying at sea ?;
17- Were you fishing day and night ?;
18- How long was the soaking time of the traps ?;
19- How long was the fishing season ?;
20- How was the crab stored on the vessels ?;
21- What kind of bait were you using ?;
22- At what depth were you fishing ?;
23- What is the estimated number of traps lost at sea each year ?;
24- Were you fishing other species than snow crab ?;
25- Was there any by-catch in your snow crab traps ?;
26- Did you notice any changes in the biology of the snow crab with time ?;
27- General comments.

The data was compiled and analyzed on a Macintosh micro computer. Charts were drawn using Deltagraph and Canvas software. All calculations were made using Statsview software. An attempt was made to standardize the unit of effort to the 1.52 m rectangular trap using the information provided by this survey according to the ratio from Dufour, 1984 in order to evaluate its effect on the catch rate series over time.

RESULTS AND DISCUSSION

The number of fishermen interviewed who were active during the period of 1966 to 1989 varied from a minimum of 2 in 1966 to a maximum of 44 in 1984-85 (Figure 5). Snow crab permits bacame mandatory in 1972. As the fishery progressed, an increasing number of snow crab fishermen were getting involved in other fisheries. By 1989, up to 41% of the fishermen interviewed were holding at least another fishing permit (Figure 6).

Vessels

The type and size of vessels used by the New Brunswick snow crab fleet varied considerably throughout the fishery. In the 1960's, the most popular types of vessels were the "GLOUCESTERS", the "CHALEURS", and the "TROLLERS" (Figure 7). In the 1970's, the "GLOUCESTERS" were mostly used. The "CAPE ISLANDERS" which appeared in the late 1960's, were used in the 1970's but became almost nonexistent in the early 1980's. The metal and the wooden "CRAB BOAT" which first appeared in the early's 1970's became the most popular in the 1980's. The latter is still largely used today.

Another "CRAB BOAT" made of fiberglass appeared in the early 1980's and is still used today. From the start of the fishery, there is an increasing trend in the size of the snow crab fishing vessels used by the New Brunswick fleet (Figure 8). The average length increased from 16 m (53 ft) in 1966 to 19.5 m (64 ft) in 1989. The vessels could therefore accommodate more crew members which increased from an average of 4 members in 1966 to 5.1 members in 1989 (Figure 9). With the increase in the size of the vessels, more powerful engines were used. The average power of the engines increased from 200 horse power in 1966 to 367 horse power in 1989 (Figure 10). The mean hold capacity of the vessels also increased considerably from approximately 9000 kg (20000 lbs) in 1966 to over 18000 kg (40000 lbs) in 1989 (Figure 11).

Navigation and communication equipment

Vessels became better equipped with navigational aids in the mid 1970's. All vessels were equipped with radars by 1983 (Figure 12) and with Loran C by 1987 (Figure 13). Fishing activities during the night which started in the mid 1970's (Figure 14), became very popular in the early 1980's with the increased number of lights on the vessels (Figure 15). In 1989, the number of fishermen who were active during the night decreased considerably due to the bad state of the resource (high percentage of crab with soft shell). The use of better communication systems (V.H.F. and side band radios) became prevalent in the early 1980's (Figure 16). Vessels equipped with better navigational and communication equipment and with higher hold capacity helped increase the length of their fishing trips in the 1980's. By 1989, it had reached an average of 2.5 days per trip (Figure 17). Greater distances from home ports were also travelled in the early 1980's with 31% of the fishermen who started fishing on Bradelle Bank and around Magdalen Islands in comparison to 9.5% in 1968-70, 10% in both 1971-73 and 1974-76, 17% in 1977-79 and finally 19% after 1983.

Traps and trap hauler

Our study showed that only rectangular traps measuring 1.5 m (5 ft) at the base were used at the start of the fishery (1966-67) by the New Brunswick fleet (Figure 18). Gradually, this trap was replaced by a bigger rectangular trap measuring 1.8 m (6 ft) at the base. In 1985, all fishermen interviewed were using the 1.8 m rectangular trap.

The catchability of traps is dependant on several factors such as the type of bait, trap fishing time, temperature, stage of molt cycle, trap design and saturation of the trap (Miller, 1975). The shape and size of traps

changed throughout the history of the fishery. Bailey and Cormier (1983) reported this change in trap size and concluded that the use of larger traps underestimated the fishing effort which in turn resulted in an overestimate of the catch rates. Bailey and Dufour (1983) reported that some fishermen from different areas of the Gulf of St. Lawrence were using a smaller trap, conical in shape, measuring 1.2 m (4 ft) at the base. They showed that the rectangular trap measuring 1.5 m (5 ft) at the base was twice as efficient as the small conical trap. Another study by Dufour (1984) revealed a conversion factor of 2-3:1:3.5 between the rectangular trap with a base of 1.5 m (5 ft), the small conical trap with a base of 1.2 m (4 ft) and the rectangular trap with a base of 1.8 m (6 ft). Coulombe (1987) also reported a continuous change in trap size and shape since the beginning of the fishery. In a retrospective study on trap selectivity, he attributed a trap efficacy to three main factors: the escape of sublegal sized snow crab, the ease of handling (weight, ability to stack), and the increase in catch rates of legal sized crab. The author showed that the small conical trap has an advantage for the first two factors but the rectangular trap performs better because of its size. New trap types (conical and pyramidal shapes) were introduced in 1986 which regrouped the three advantages earlier mentioned. In a study of catchability of these different traps all measuring 1.8 m (6 ft) at the base, Moriyasu et al. (1990) showed that the pyramidal and the conical traps were catching larger crabs than rectangular traps. The catch rates of the pyramidal and conical traps were also higher than that of the rectangular traps.

In the early years of the fishery, trap haulers were made with car differentials and pulleys and handled manually. In the late 1970's, these haulers were replaced by more efficient powerblock haulers. The traps could therefore be hauled faster, allowing the fishermen more time to move the traps around on the fishing grounds.

Fishing activities

By 1989, most fishermen were using conical and pyramidal traps (Figure 18) which were known to increase the mobility of the fleet (Mallet et al., 1988). The higher efficiency of the fleet and higher fishing pressure (day and night) contributed to the quick removal of accumulated biomass of morphometrically mature crabs from the fishing grounds (Mallet et al., 1989). The increase in the mobility of the fleet and the decrease in the biomass resulted in a higher degree of gear shifting on the fishing grounds (Figure 19) and the traps soaked for longer periods (Figure 20). Although the effect of the type of bait on the catchability of snow crab is not documented, this survey revealed that herring and mackerel were

predominantly used up to the late 1970's but fishermen preferred to use mackerel and squid in the 1980's (Figure 21).

Ghost fishing

Mallet et al. (1988) reported that a considerable number of traps were lost at sea (2466) in 1987 due to ice shifting during the start of the season (spring). This survey showed that the highest value (28 lost traps per fishermen) was recorded in the 1983-85 period (Figure 22). The effect of ghost fishing on snow crab stocks is not well known but could be minimized by opening the fishery once the gulf is free of ice and/or using traps equipped with galvanic time releases (Gagnon et Boudreau, 1991).

Characteristics of the periods

The four periods in the history of this fishery can be characterized as follows:

Period I (1966-75) - Period of exploration with increasing but fluctuating catches, annual mean of 4641 t.
- Annual catch rate fluctuating, annual mean of 32.2 kg/trap haul.

Period II (1976-80) - Period of fishery expansion with catches increasing constantly to around 15000 t, annual mean of 11643 t.
- Annual catch rate fluctuating, annual mean of 30.2 kg/trap haul.

Period III (1981-86) - Period of high catches stabilizing at around 25000 t, annual mean of 25548 t for the period.
- Annual catch rate stable but substantially higher than period II, annual mean of 55.1 kg/trap haul for the period.

The relationship between annual averaged CPUE's versus annual total estimated fishing effort suggests drastic changes in the fishery for period III (Figure 4). The catch rate series for this period are probably overestimated due to a possible underestimation of the effort. The use of larger and better performing traps during that period could not be taken into consideration due to the rapid changes in the type of traps used and the lack of documented information. Our survey showed significant changes in the unit of effort during the four periods which can be summarized as follows (numbers in percentage):

Type of traps	Period I	Period II	Period III	Period IV
Rectangular 1.52 m (5 ft.)	68.6%	39.1%	8.1%	0%
Rectangular 1.83 m (6 ft.)	31.4%	60.9%	87.4%	37.0%
Conical and Pyramidal	0%	0%	4.6%	63.0%

After standardization of the unit of effort to the 1.52 m rectangular trap using the smallest and greatest conversion factor, the relationship between annual averaged CPUE's versus annual total estimated fishing effort shows that the swarm of points in the 1981-86 period are still not amenable to surplus production modelling (Figure 23). The catch rate series can probably not be standardized using only the unit of effort. Other factors such as the expansion of the fishing grounds and the increase of the fishing power of the fleet are probably responsible for the increase of the catch rate during that period.

- This period is also marked by the largest increase (36%) in the mean horse power of the boat's engine and the mean hold capacity (37.3%) compared to the other periods. Most of the boats were also better equipped with radars (99%), Loran C (87%), side band (91%) and VHF radios (89%) than for periods I and II.

Period IV (1987-89)
- Catches dropping by more than 50%, mean of 10673 t for the period.
- Annual catch rate reduced by more than 50%, mean of 24.0 kg/trap haul for the period.
-During this period, no new development in the technology was reported. However, the majority of the fishermen were reporting using the larger conical and pyramidal traps and shifting them more often on the fishing grounds in order to maximize their catch rates.

General comments

The most popular general comments given by the fishermen during the interview were:

1. There should be individual boat quotas for this fishery;
2. There should be more control in the number of traps;
3. The fishing grounds should be cleaned to eliminate ghost fishing;
4. The fishing activity at night should not be allowed.

CONCLUSION

This survey has shown the evolution of the New Brunswick snow crab fishing fleet in terms of technology and fishing patterns. A drastic expansion is noted in the early 1980's. Fishermen became better equipped with bigger boats, more powerful engines, larger cargo hold capacity and better navigational and communication equipment. With this more advanced technology, fishermen started to change their fishing pattern. They started to fish during the night with the aid of lights, used bigger and more efficient traps, shifted their traps more often on the grounds, stayed longer at sea, soaked their traps for longer periods of time and changed the type of bait used. The increase in landings from 1978 to 1982 seems to be strongly correlated to a result of this expansion and the more efficient harvesting of the resource by the fleet rather than a higher stock biomass.

This survey also shed some light on the confusion that exists around the use of historical catch rates as a tool to study the fluctuations of the Southwestern Gulf of St. Lawrence snow crab biomass. The fishing power of the new traps and the extent of its utilization could have a major bias in the estimation of effort.

This survey only dealt with the New Brunswick snow crab fleet. A thorough study of the evolution of the Québec fleet should also be conducted to better understand the evolution of the whole Southwestern Gulf of St. Lawrence fishery.

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REFERENCES

Bailey, R. and R. Cormier. 1983. Revue du stock de crabe des neiges exploité par le Nouveau-Brunswick en 1983 dans le sud-ouest du Golfe Saint-Laurent. CAFSAC Res. Doc. 83/79: 34 p.

Bailey, R. and R. Dufour. 1983. Comparaison des rendements de crabe des neiges obtenus par deux types de casiers différents. CAFSAC Res. Doc. 83/19: 14 p.

Cormier, R. 1984. A preliminary analysis of the New Brunswick snow crab (Chionoecetes opilio) fishery in the Southwestern part of the Gulf of St. Lawrence. CAFSAC Res. Doc. 84/83: 10 p.

Coulombe, F. 1987. Rétrospective sur la sélectivité des casiers à crabe des neiges de la côte atlantique du Canada. CAFSAC Res. Doc. 87/82: 13 p.

Dufour, R. 1984. Rendements comparatifs et sélectivité de trois types de casiers à crabes des neiges. CAFSAC Res. Doc. 84/1: 25p.

Elner, R.W. 1982. Overview of the snow crab Chionoecetes opilio fishery in Atlantic Canada. Proc. Int. Symp. Genus Chionoecetes, Alaska, Sea-Grant Rep. 82-10: 3-20.

Gagnon, M. and M. Boudreau. 1991. Sea trials of a galvanic corrosion delayed release mechanism for snow crab traps. Can. Tech. Rep. Fish. Aquat. Sci. 1803: 17 p.

Mallet, P., Y. Chiasson and M. Moriyasu. 1988. A review of catch, fishing effort and biological trends for the 1987 Southwestern Gulf of St. Lawrence snow crab, Chionoecetes opilio fishery. CAFSAC Res. Doc. 88/32: 39 p.

Mallet, P., E. Wade, Y. Chiasson, P. DeGrâce, G.Y. Conan and M. Moriyasu. 1989. La pêche du crabe des neiges (Chionoecetes opilio) dans le sud-ouest du golfe Saint-Laurent en 1988: L'analyse des prises,de l'effort de pêche et l'estimation de la biomasse. CAFSAC Res. Doc. 89/25: 59 p.

Miller, R.J. 1975. Density of the commercial spider crab, Chionoecetes opilio, and calibration of effective area fished per trap using bottom photography. J. Fish. Res. Board Can. 32: 761-768.

Moriyasu, M., Y.J. Chiasson and P. DeGrâce. 1990. Study on catchability and size structure of snow crab (Chionoecetes opilio) in relation to three trap types. CAFSAC Res. Doc. 90/29: 16 p.

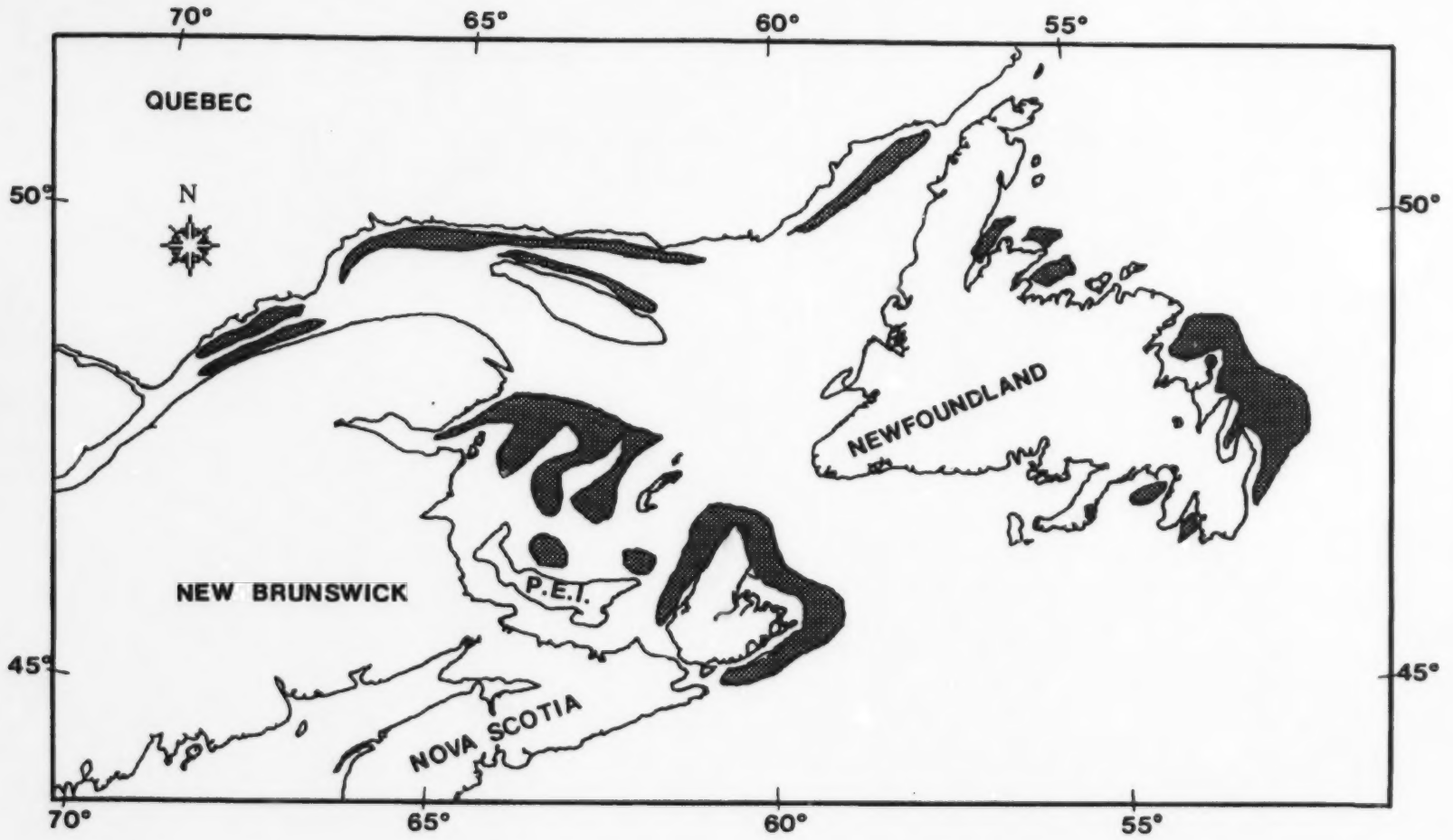

Fig.1. Distribution of snow crab, Chionoecetes opilio, stocks (hatched zones) exploited in eastern Canada. (Adapted from Elner, 1982).

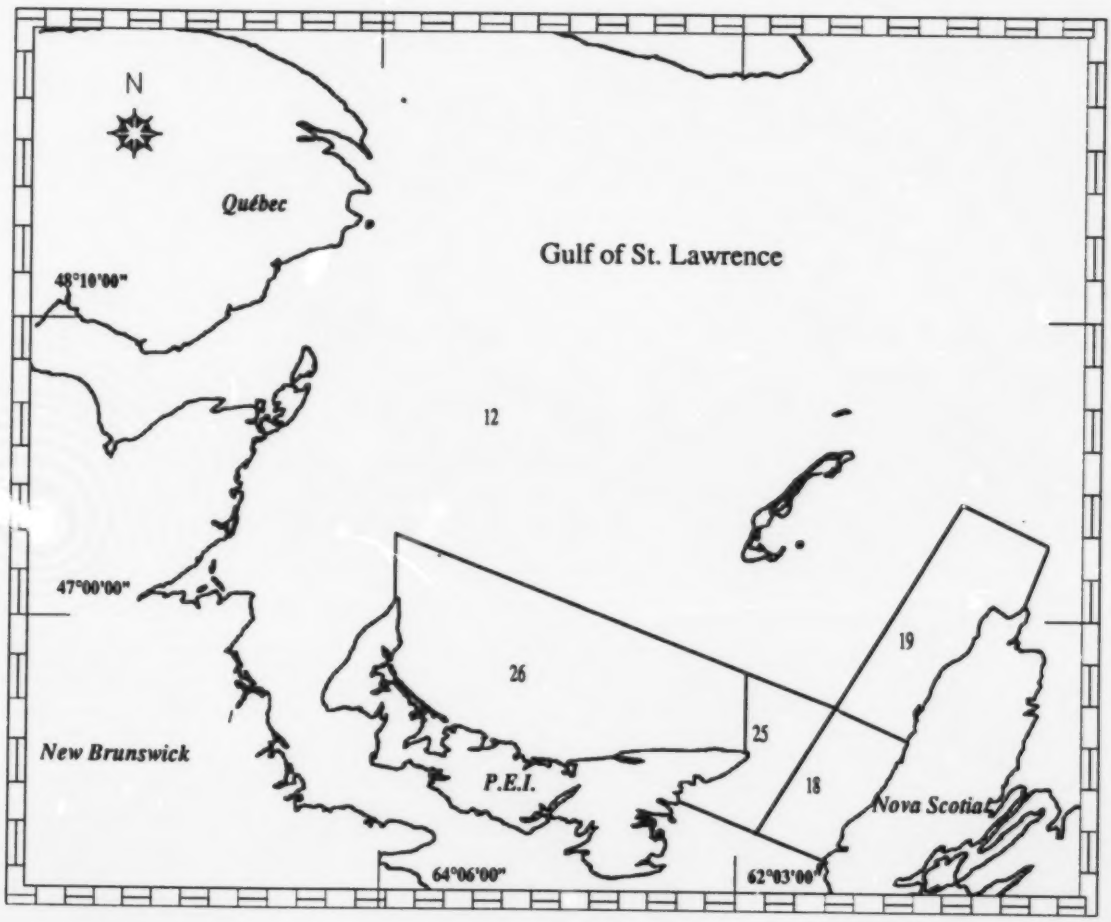

Figure 2. Southern Gulf of St. Lawrence, Chionoecetes opilio, management zones.

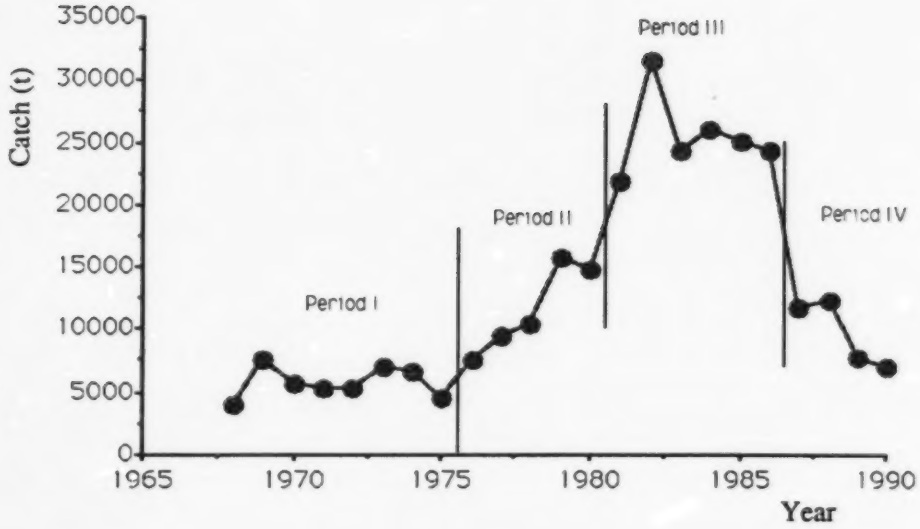

Fig.3. Snow crab (Chionoecetes opilio) landings in the Southwestern Gulf of St. Lawrence from 1968 to 1990.

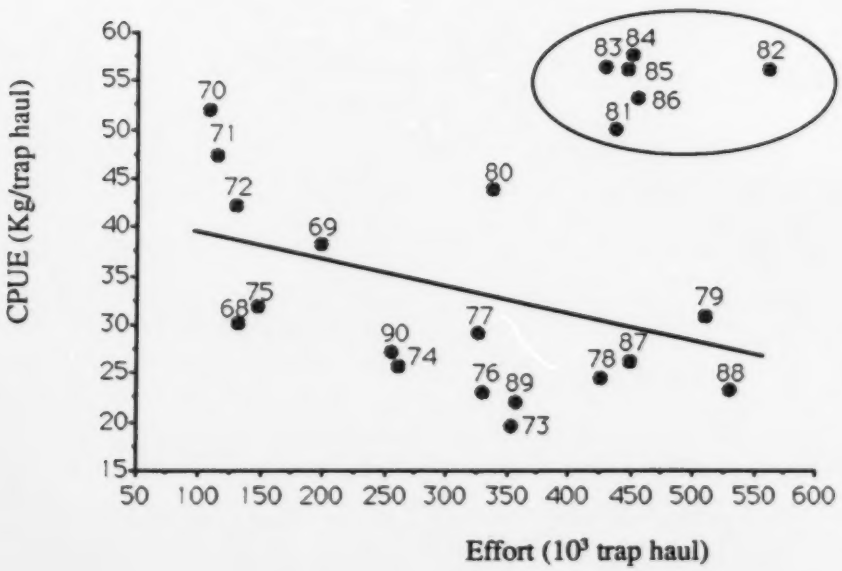

Fig.4. Evolution of CPUE vs. non standardized effort in historical records of the Southwestern Gulf of St. Lawrence snow crab fishery from 1968 to 1990.

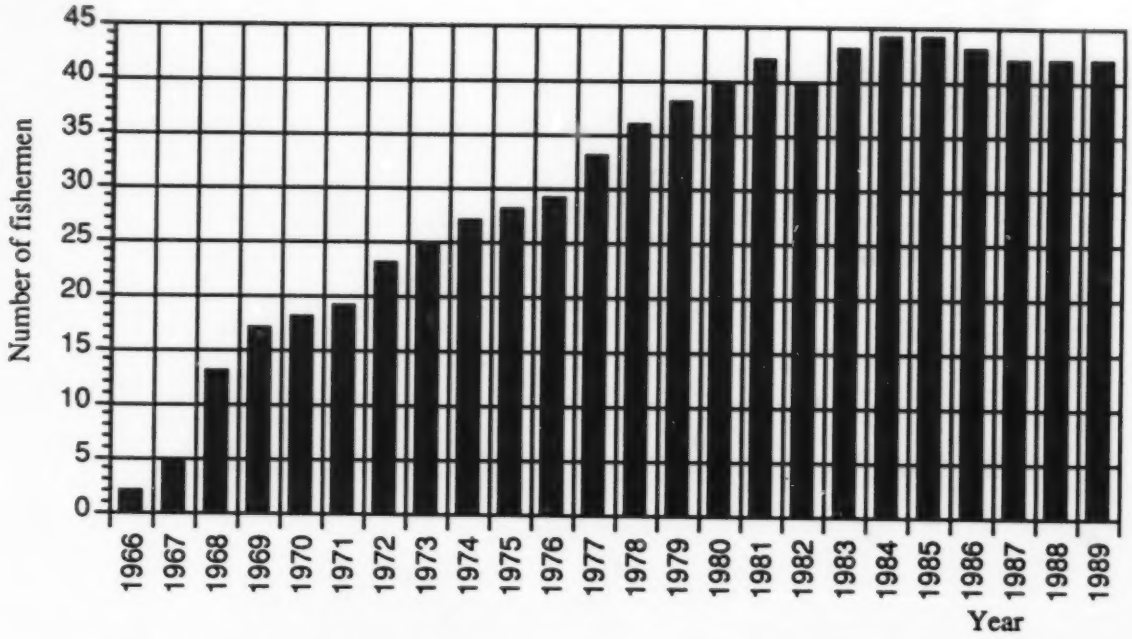

Fig.5. The number of snow crab fishermen interviewed who were active during the period of 1966 to 1989.

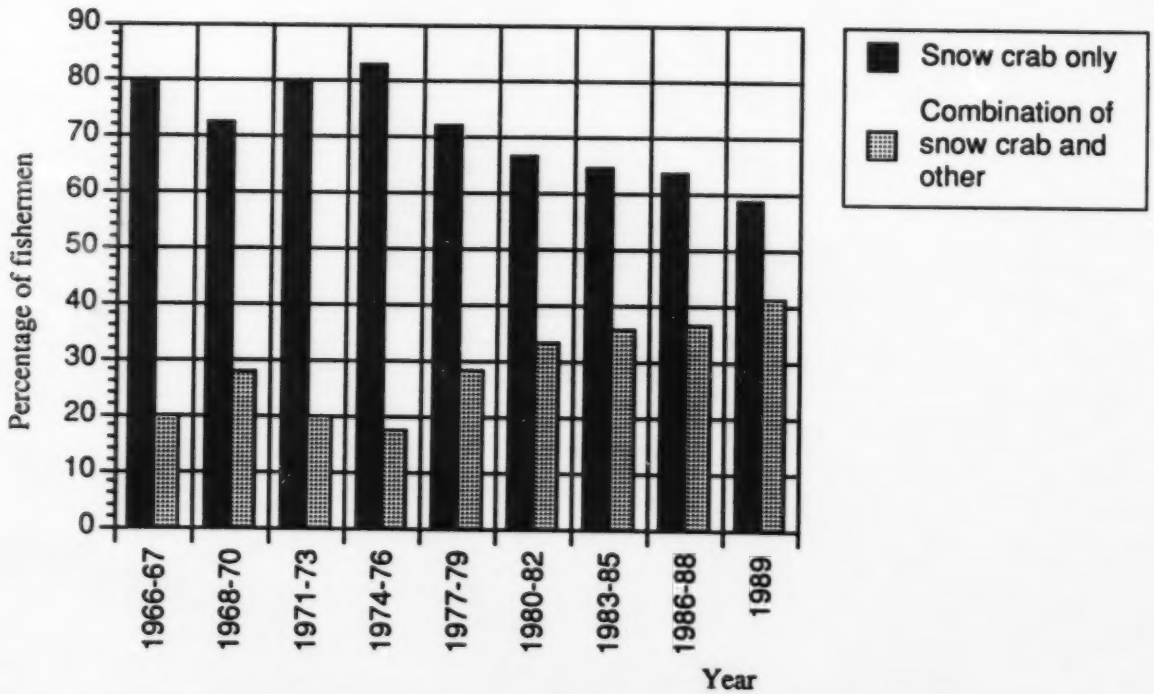

Fig.6. The percentages of fishermen with snow crab permits only and with a combination of snow crab and other permits from 1966 to 1989.

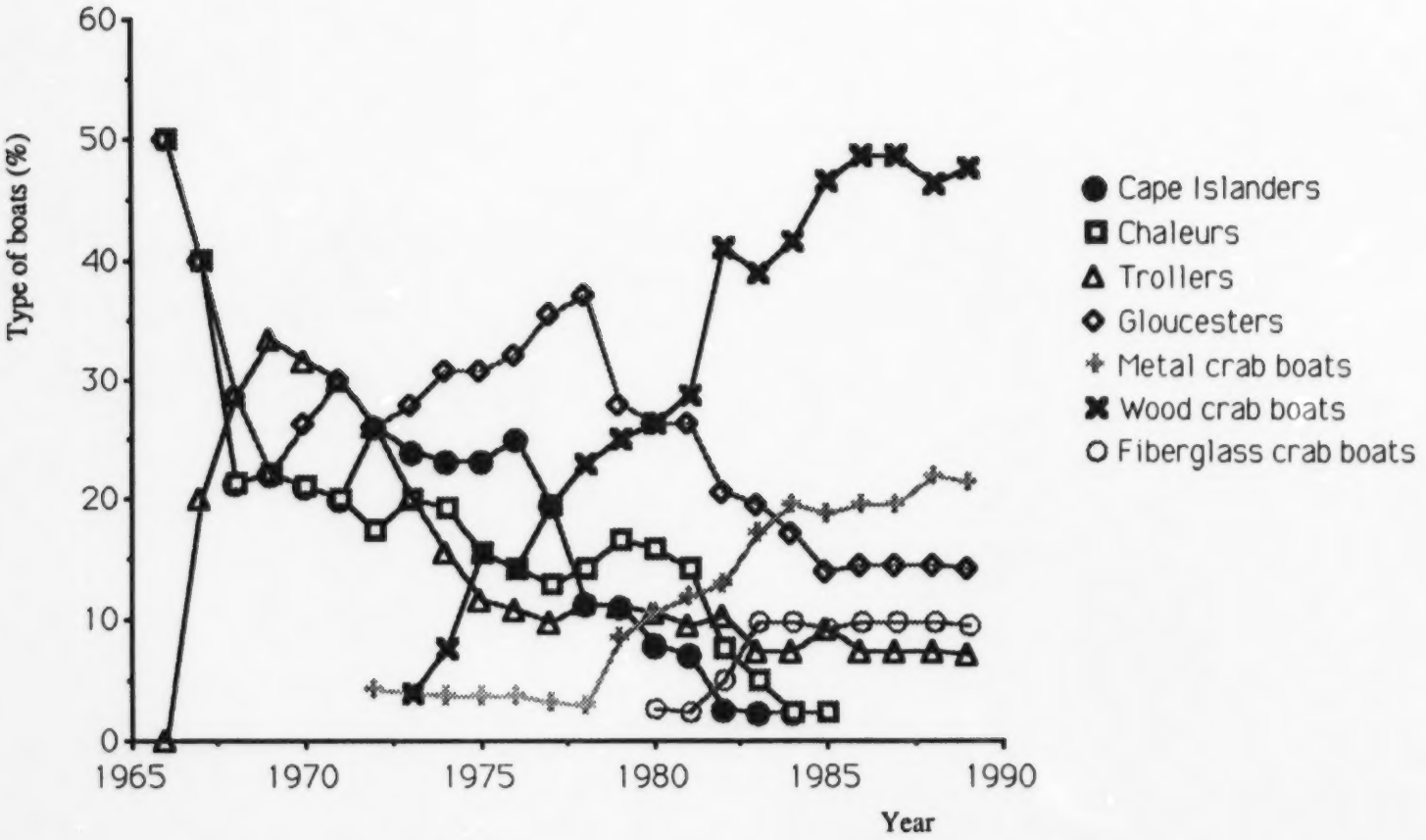

Fig.7. The percentages of snow crab fishermen using different types of boat from 1966 to 1989.

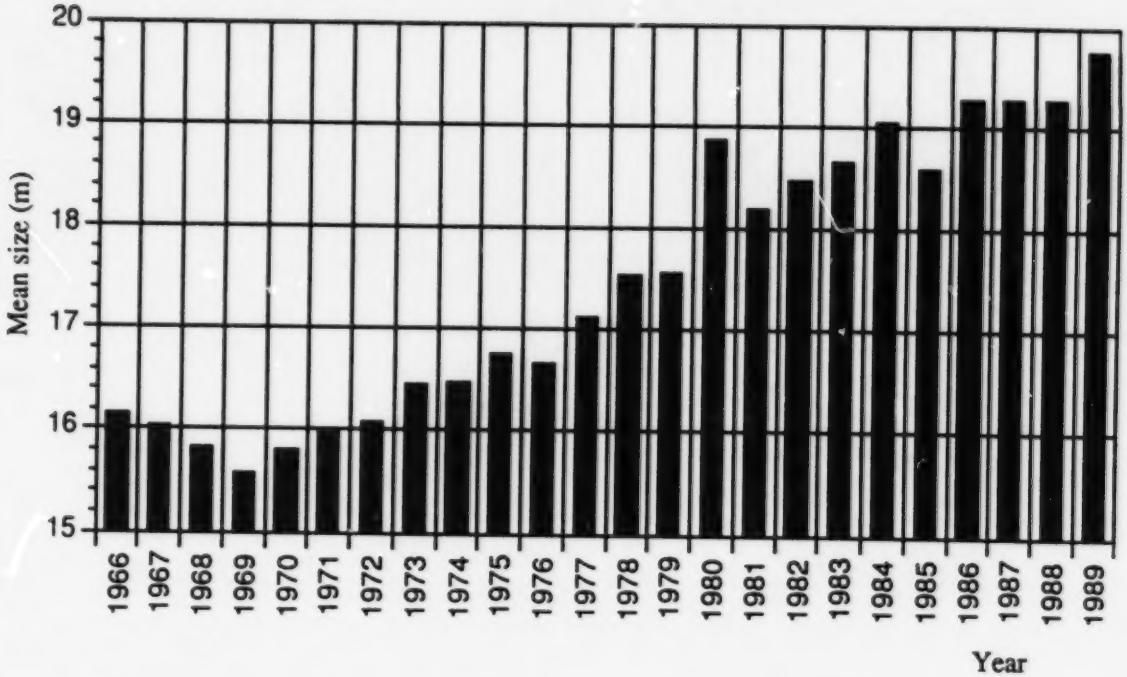

Fig.8. The mean length of boats (m) used by snow crab fishermen from 1966 to 1989.

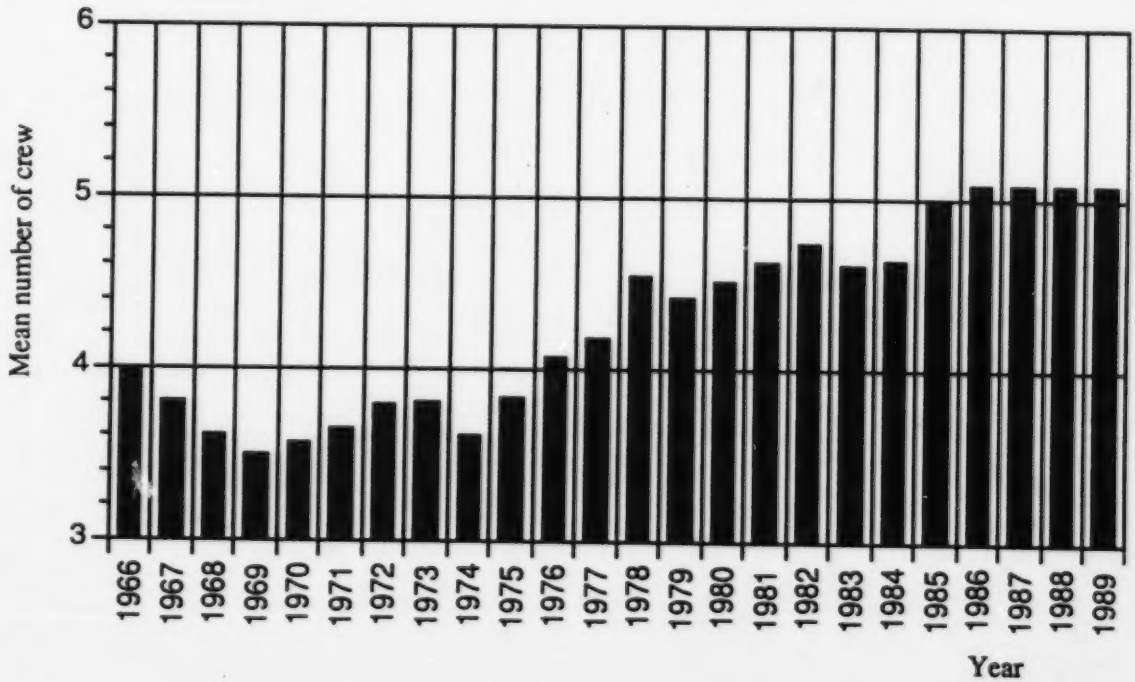

Fig.9. The mean number of crew operating on snow crab boats from 1966 to 1989.

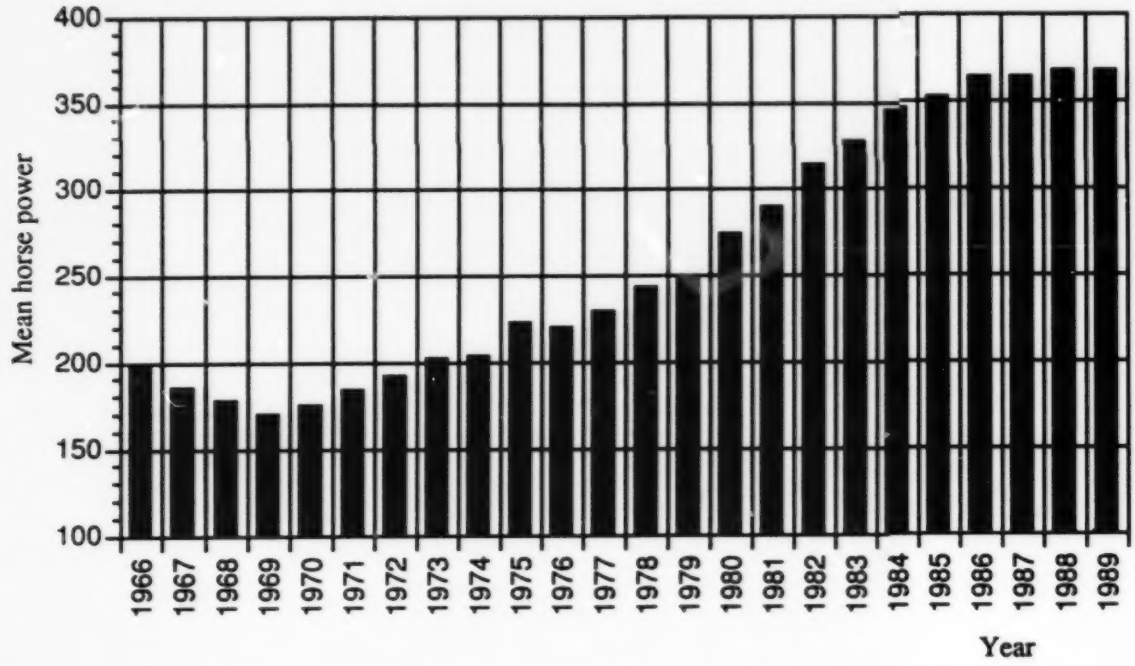

Fig.10. The mean horse power of snow crab boat's engine from 1966 to 1989.

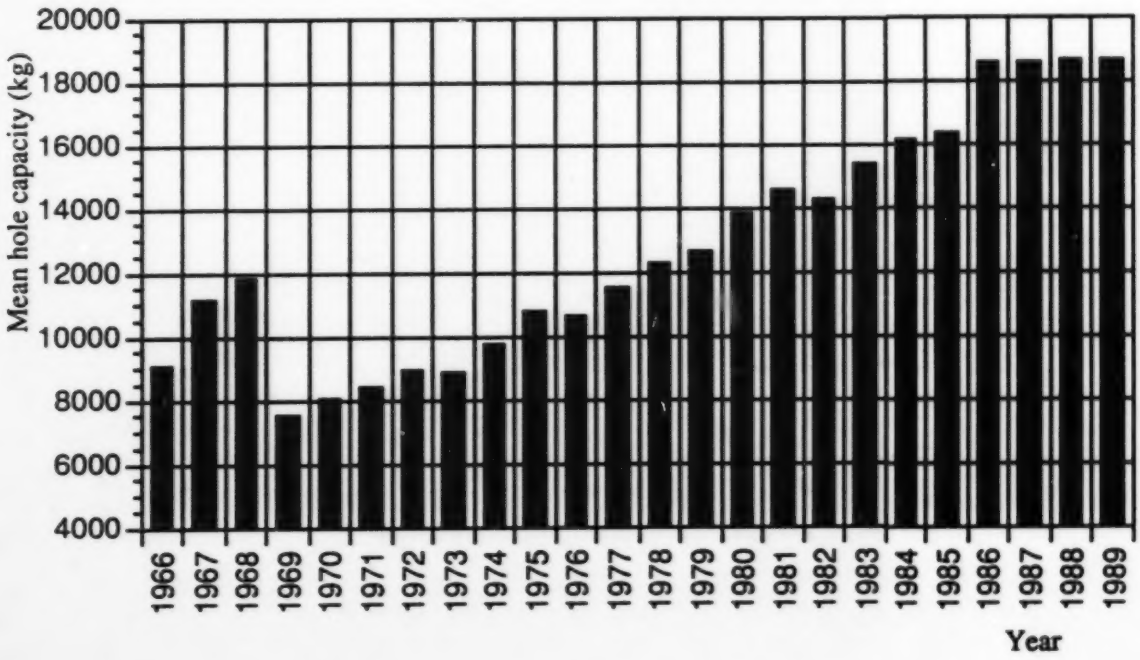

Fig.11. The mean hold capacity (kg) of boats used by snow crab fishermen from 1966 to 1989.

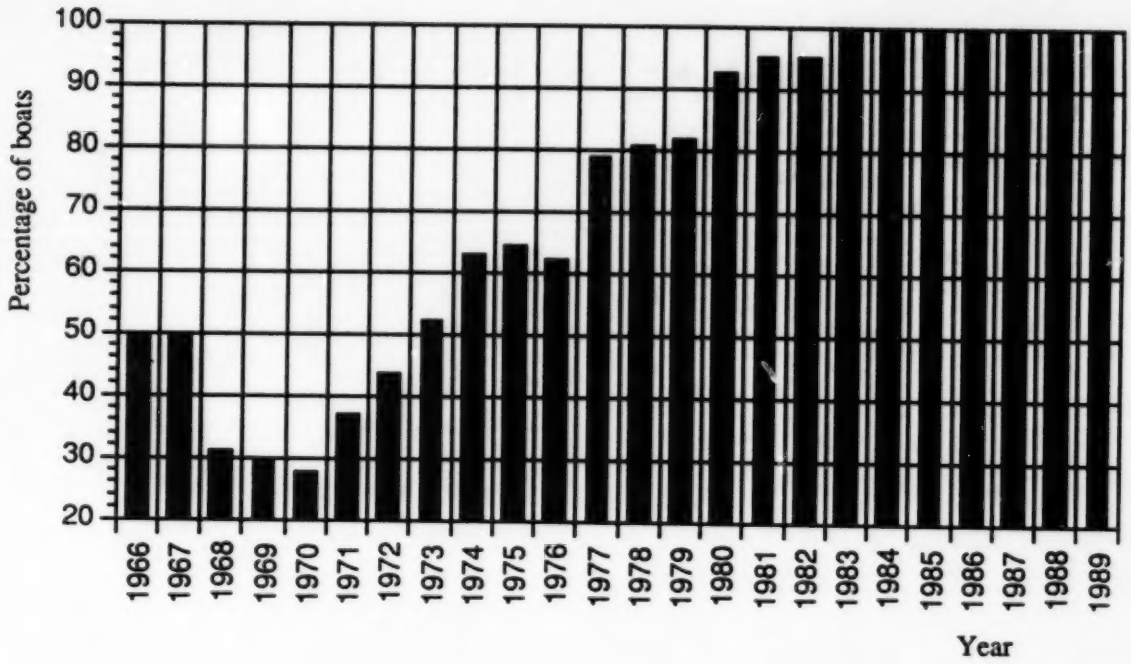

Fig.12. The percentages of snow crab boats equipped with radars from 1966 to 1989.

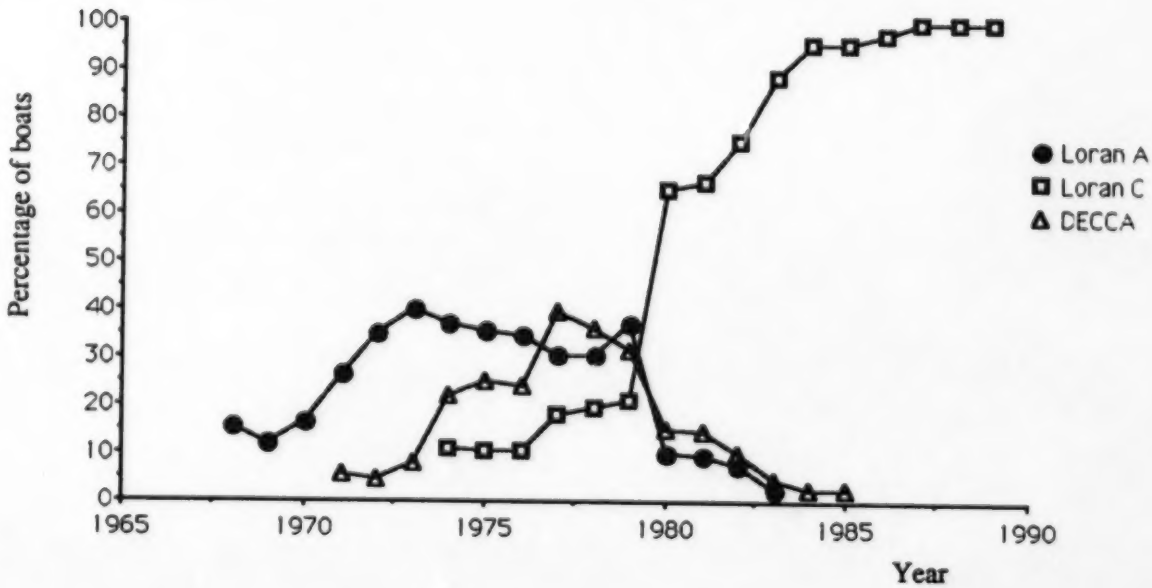

Fig.13. The percentages of snow crab boats equipped with different types of positionning system from 1966 to 1989.

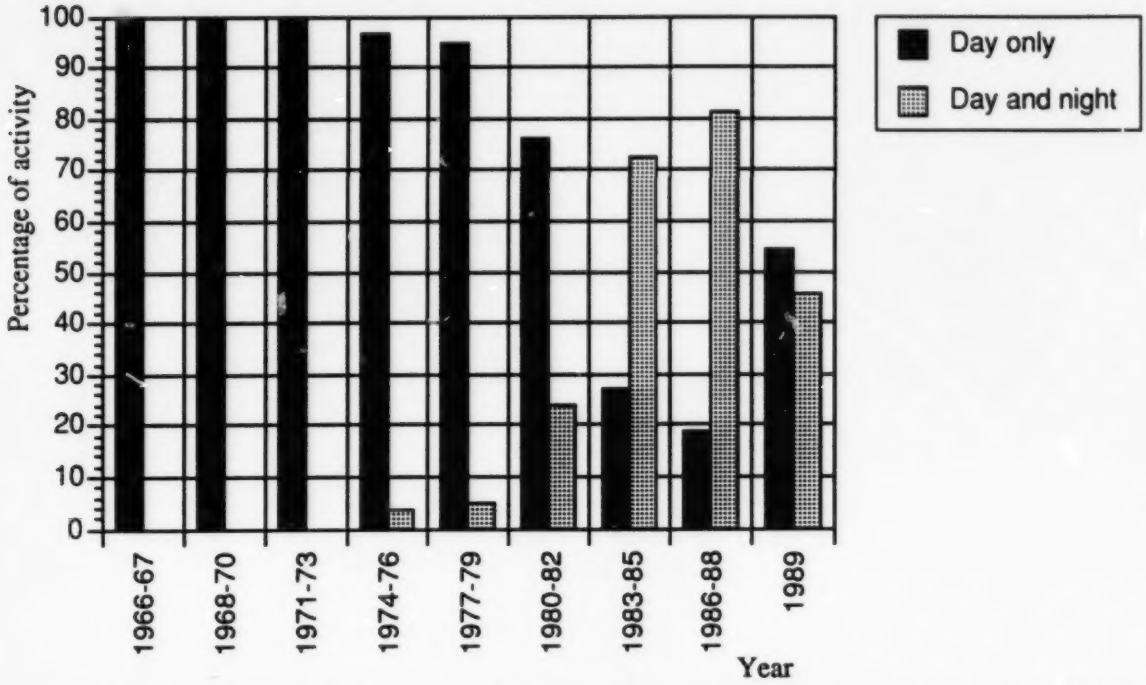

Fig.14. Percentages of day fishing only and combination of day and night fishing for the snow crab fishery from 1966 to 1989.

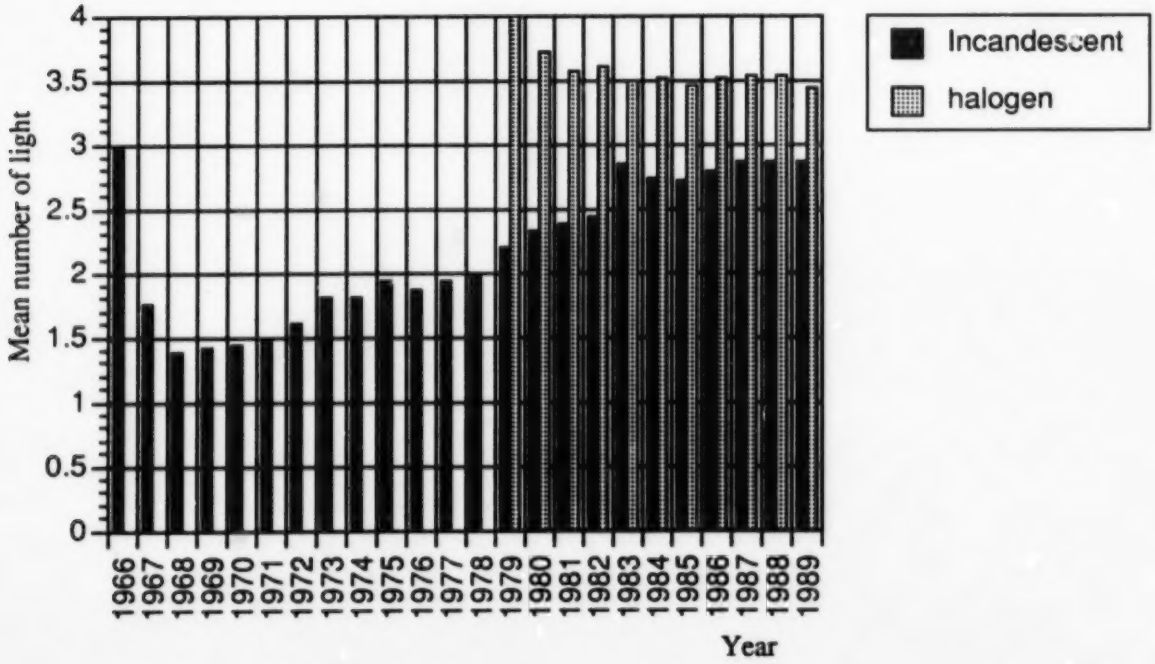

Fig.15. The mean number of incandescent and halogen lights per snow crab boat from 1966 to 1989.

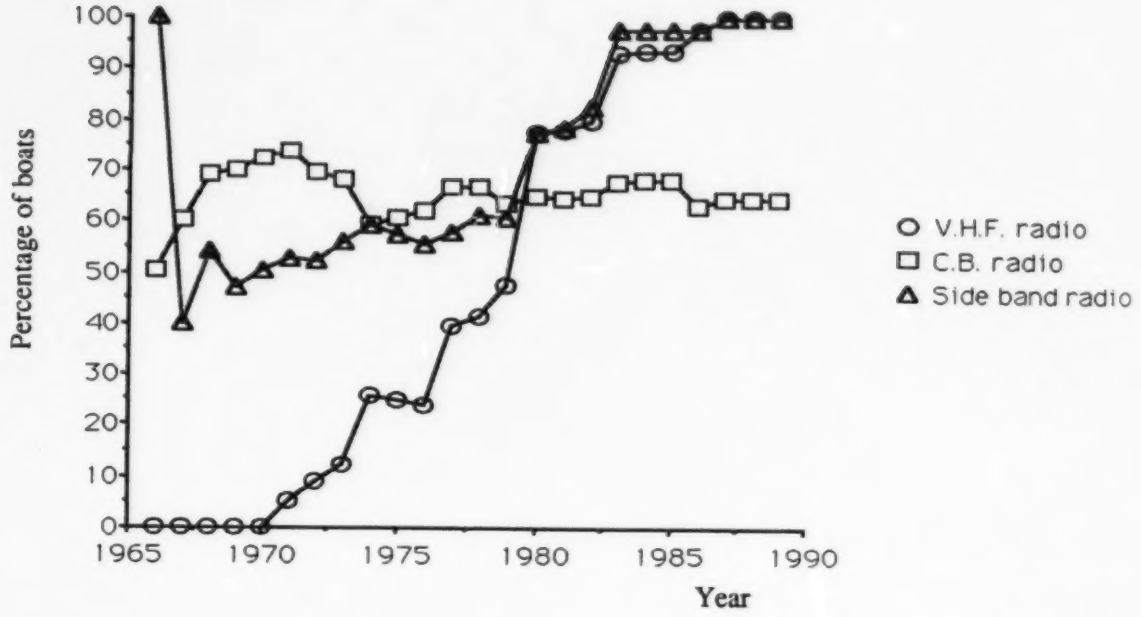

Fig.16. The percentages of snow crab boats using different types of radio from 1966 to 1989.

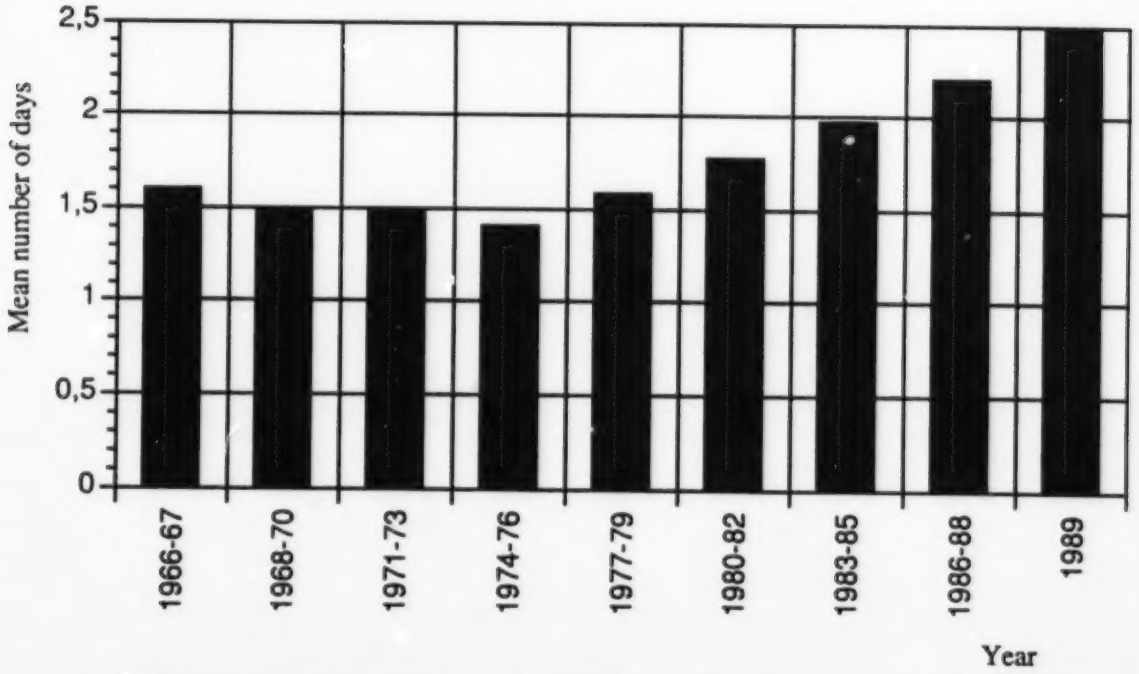

Fig.17. The mean number of days at sea per boat per trip for the snow crab fleet from 1966 to 1989.

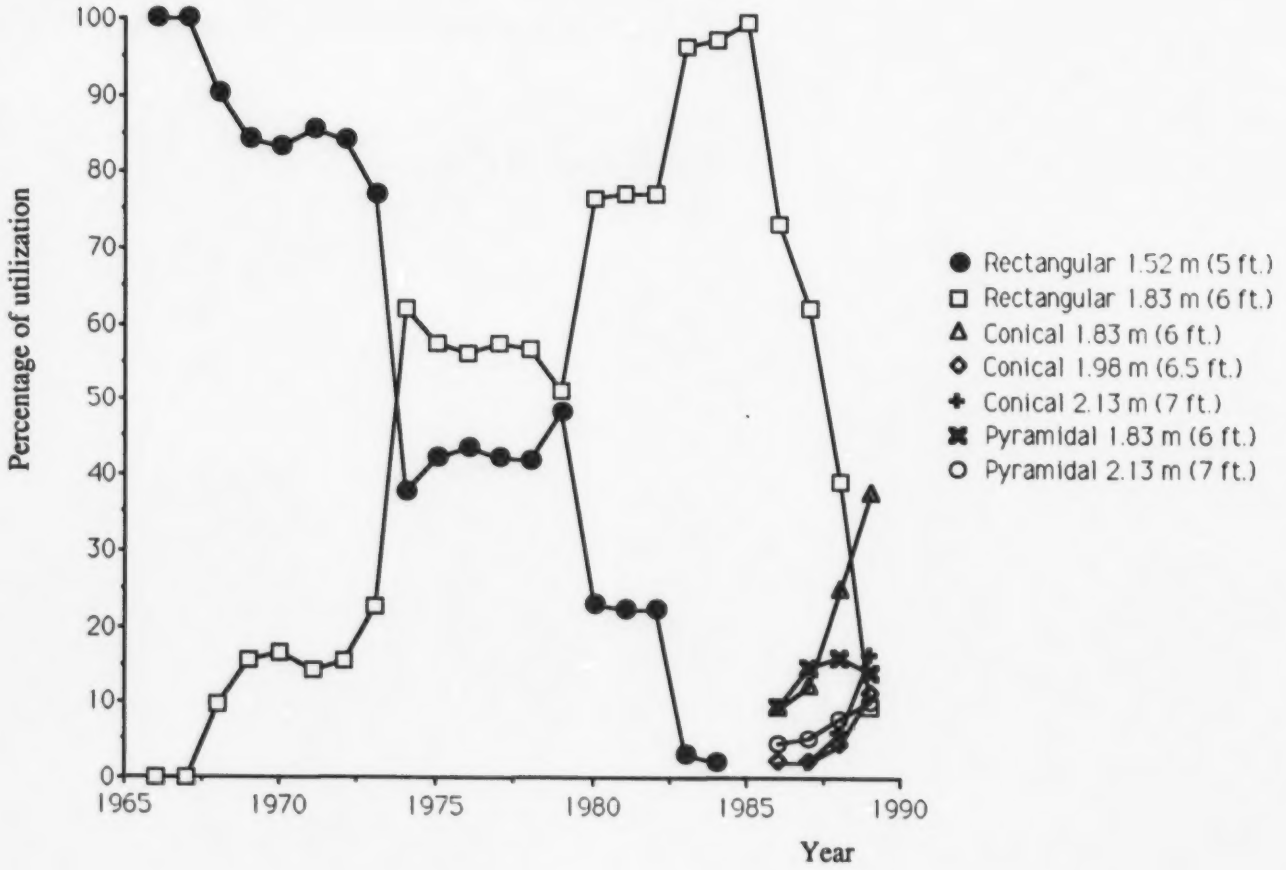

Fig.18. The percentages of utilization of different type of traps since the fishery started in 1966.

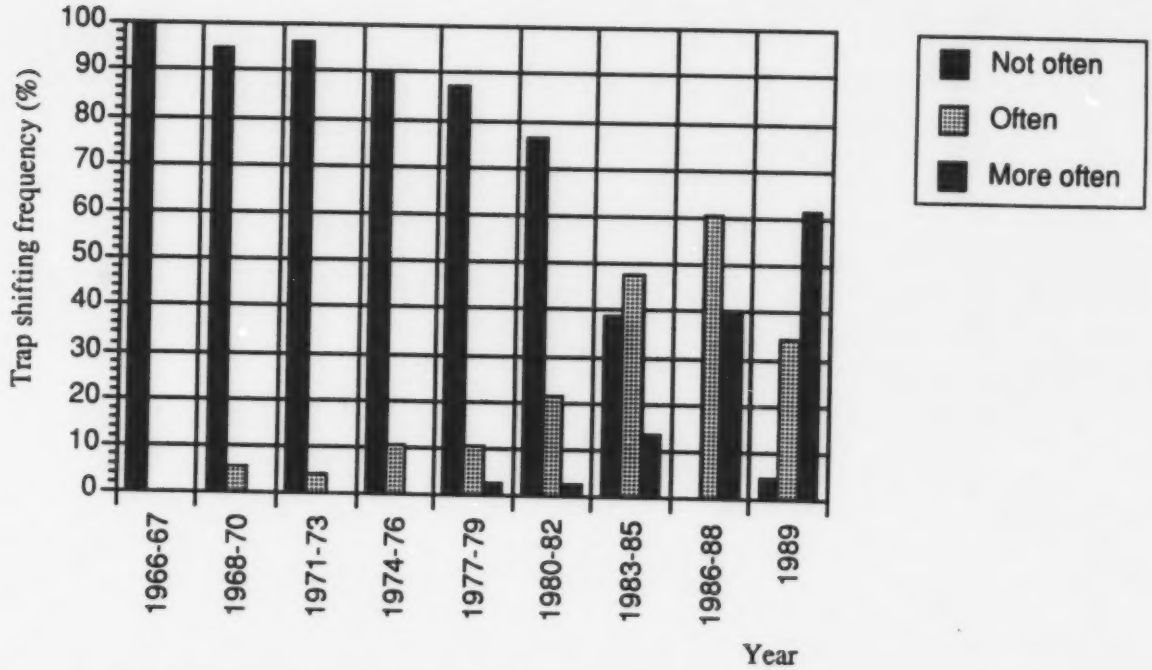

Fig.19. The percentages of trap shifting frequency on the snow crab fishing ground from 1966 to 1989.

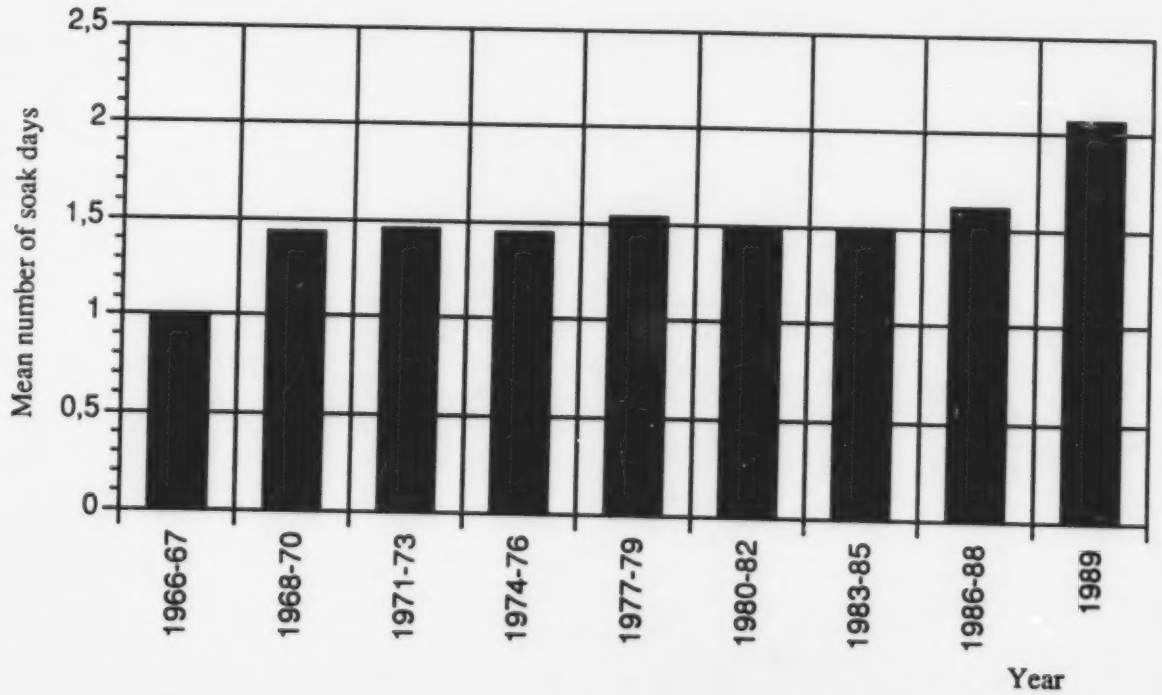

Fig.20. The mean number of soak days of snow crab traps from 1966 to 1989.

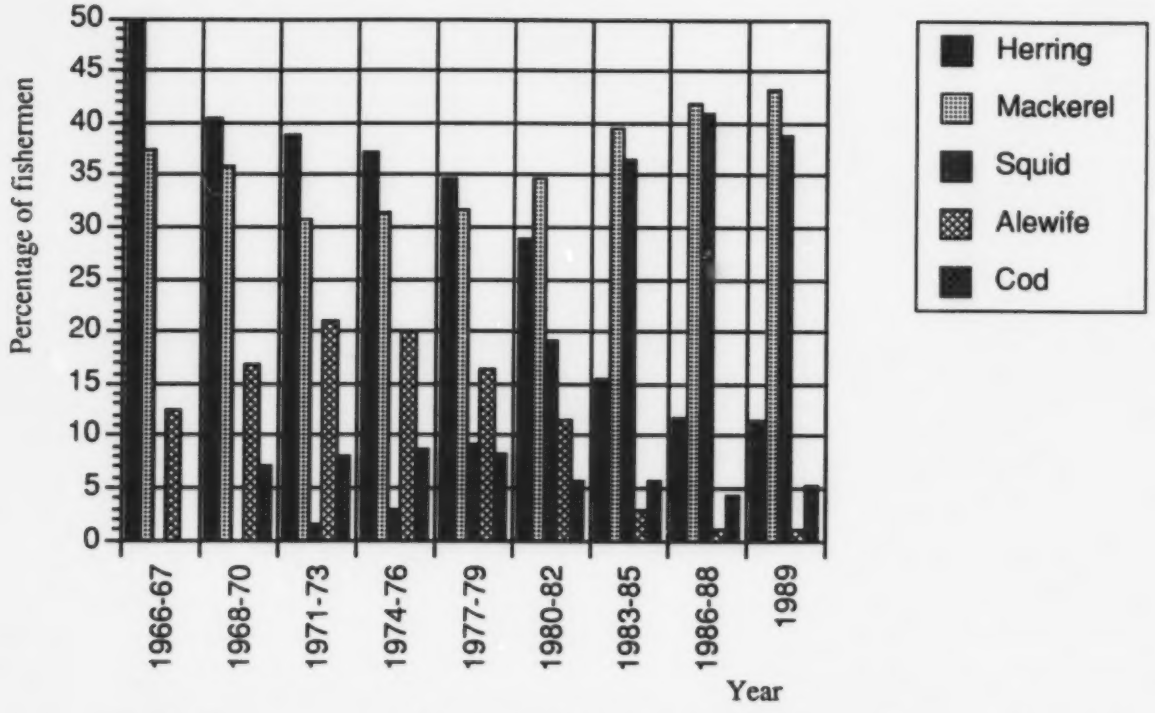

Fig.21. The percentages of snow crab fishermen using different types of bait from 1966 to 1989.

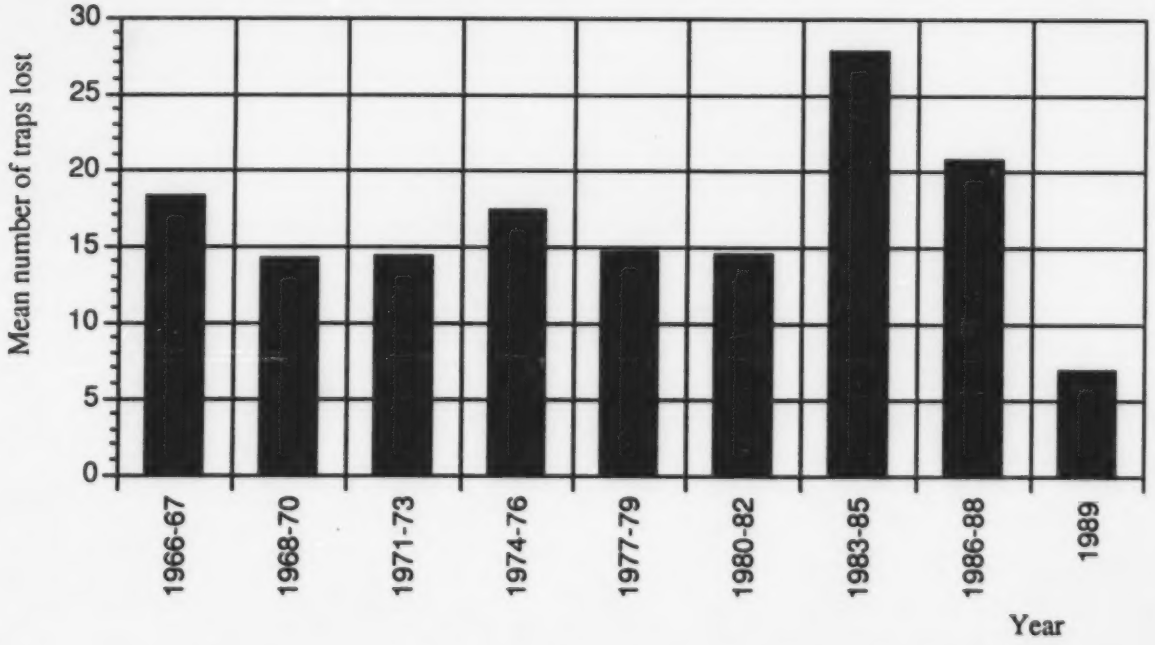

Fig.22. The mean number of traps lost at sea per snow crab boat from 1966 to 1989.

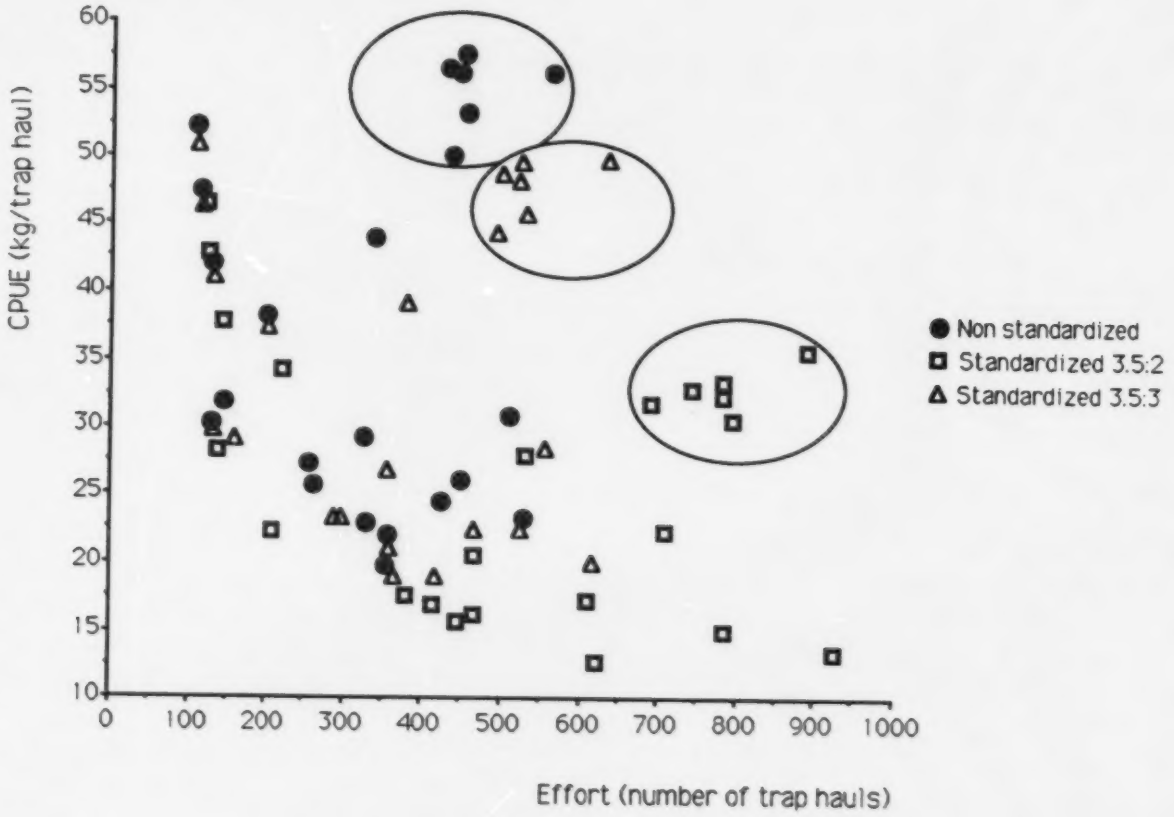

Fig.23. Evolution of CPUE vs. non standardized and standardized (1.5 m rectangular trap : 1.8 m rectangular trap) effort in historical records of the Southwestern Gulf of St. Lawrence snow crab fishery from 1968 to 1990. The 1981-86 period is enclosed in an oval.